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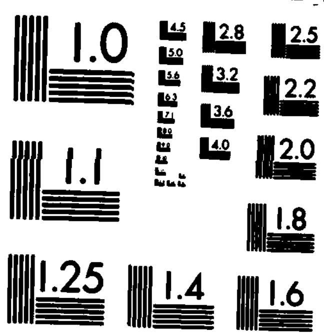
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ETL-0390

SYSTEM ANALYSIS OF A FIELD ARMY

TOPOGRAPHIC SUPPORT SYSTEM

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Prepared for:

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In 1978, Decilog completed a Computer Simulation Model of the Topographic Support System (TSS) under Contract for the Engineer Topographic Laboratories (ETL). As a result of exercising that Model, it was possible to conclude that the TSS, as configured by an interagency Integrated Equipment Evaluation Team, was capable of producing the required Products and Services in a manner which was then considered timely.

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With the passage of time, however, there were changes in the TSS design and environment. Furthermore, the 1978 model was restricted to a particular scenario. For these reasons, it was desirable to revise the 1978 model to both update it and remove the restrictions.

In addition, it was desirable to teach a Group of Government employees how to use the simulation. In this way it could be "handed over" to the Government which would then have a System Analysis tool.

The major objectives of this effort, then were to:

- Revise the Simulation Model to simplify input and add additional features to enhance flexibility.
- Install ETLSIM on the ETL Cyber 170 and train Government personnel in its use and in the analysis of the simulations
- Perform a continuing analysis of classified inputs to assure that ETLSIM could be utilized to assess their impact on field Army topographic Units

These objectives have been met.

The following modifications to the 1978 model were completed:

- The model was modified to conform with changes made by MERADCOM for the fabrication contract
- The Product Lists were revised

As these changes were added to the code the simulation program became more and more complicated. Since a prime objective was to have Government personnel learn how to use the system, this complication was especially bad. Therefore, it was decided to scrap the 1978 simulation and completely rewrite the code. A product of this rewriting is a program in which the analyst specifies the characteristics of the system which is to be simulated. The program then "builds" the system, simulates its operation and produces a statistical report. This capability, ETLSIM, has the following features:

- The Direct Support vehicle was simulated rather than ignored
- The product list is easily modified by the analyst
- Alternate paths through production steps have been provided
- It is now easy for the analyst to "install" new equipments in the field topographic units for analysis
- The capability of having equipments "fail" and "be repaired" as a function of Mean Time Between Failures and Mean Time to Repair has been added
- The time unit and duration of the simulated system are specified by the analyst

ETLSIM has been delivered to the Government. It was installed on and tested at the MERADCOM Computing Center and at Cyber 170 at the ETL Computing Center. A four week training course was given with extensive course materials provided. Those personnel who attended all, or nearly all, of the sessions were able to use all of the features of the model after the training.

A continuing analysis of classified inputs was conducted during the contract to insure that ETLSIM could be utilized to assess their impact on field army topographic units.

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1. Executive Summary

In 1978, Decilog completed a Computer Simulation Model of the Topographic Support System (TSS) under Contract for the Engineer Topographic Laboratories (ETL). As a result of exercising that Model, it was possible to conclude that the TSS, as configured by an interagency Integrated Equipment Evaluation Team, was capable of producing the required Products and Services in a manner which was then considered timely.

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A continuing analysis of classified inputs was conducted during the contract to insure that ETLSIM could be utilized to assess their impact on field army topographic units.

– ETLSIM has already been used to support two management decisions. The first was a problem concerning the effect of the introduction of the Quick Response Multicolor Printer (QRMP), and the second was a problem concerning design specifications for the QRMP itself. The use of ETLSIM in both cases provided the appropriate quantitative data necessary to rapidly resolve these conflicts.

Recommendations

1. Utilize ETLSIM to perform additional analyses, of systems such as the Digital Topographic Support System (DTSS). These should include studies of both system capacity (memory, input/output, peripherals, etc.) and of the interrelationships of subsystems such as DTAS, TAWS, etc.

2. Modify ETLSIM to allow the following:

   a. the option of specifying Mean Time Between Failure based upon either wall-clock time or accumulated equipment usage time

   b. the capability of specifying the number of people required at each production step (to include the possibility of steps that do not require personnel)

3. Make ETLSIM accessable through ETLNet so that it is easily available throughout the Laboratories.

4. Provide a capability to extract statistical data from multiple simulation runs.

2. Data Gathering

The data which are used by the Model, such as the Product List, Production Steps and Times, Distances between Modules, etc., all affect the fidelity of the Model. In order to produce a "high fidelity" simulation, much effort was devoted to an investigation of the environment within which the topographic units will operate. The reasons why these efforts were often frustrated are described in the following sections.

2.1 Interactions with Supported Units

During the development of the 1978 simulation, the TSS was treated as a System. This avoided consideration of Army organization, Tables of Organization and Equipment (TO&E), Chains of Command, Communication and so forth. At the beginning of this Program, it was decided to obtain information on the "real operational environment" for the field Army Topographic units.

Since the Topographic units of three Active Army Commands are to receive new equipment, namely, USAEUR, FORSCOM and WESTCOM (elements of the Joint Rapid Deployment Task Force), efforts to define the operational environment were confined to these organizations. Doctrine regarding Topographic Unit deployment was obtained from FM 21-32 Topographic Support and FM5-146 Engineer Topographic Units.

While each of the three organizations were familiar with established doctrine, each interprets it differently in the light of its geographic and presumed tactical situation. For example, the distance between some modules might be thousands of miles for WESTCOM, hundreds of miles for FORSCOM in some geographic areas and tens of miles for USAEUR. WESTCOM can produce image based products while FORSCOM and USAEUR cannot. As a further example of environmental variability, the Commander of one of the two corps currently in Europe will accept hastily produced monochrome maps, while the other will not.

Such differences permeate every level in all organizations. For this reason it is concluded that there is no standard environment for any field army topographic unit anywhere in the world.

The inherent flexibility of the TO&E will allow topographic units to respond to the needs of various Commanders in various world-wide circumstances.

In addition to the traditional Cartographic Company Survey Platoon, etc., Terrain Teams were included in the series H TO&E. A very light Terrain Team, consisting of five troops and one direct support vehicle, can be called upon by Division and Corps Commanders for support to forward areas. A twenty-five troop Terrain Team can provide support at Corps rear. As required by circumstances, a complete Topographic Battallion can provide support to Echelons Above Corps. Thus, the organization is sufficiently flexible so that variants of these configurations can be implemented as dictated by circumstances.

As will be described elsewhere in this report, ETLSIM has been designed so that the User specifies the Configuration of the Topographic Unit and, indirectly, the Scenario to be simulated. The Simulation, therefore, is as flexible as the Units to be simulated. The specific Configurations which were specified and simulated during this Program were:

- The Light Terrain Team with Direct Support Vehicle in Direct Support of Division Intelligence assets

- The twenty-five troop Terrain Team with up to five Terrain Analysis Modules in Direct Support of Corps rear

- The entire Topographic Batallion Co-located of Echelon Above Corps in General Support

In each of the above configurations, one or more QRMP Modules were added for certain experiments. These configuration. onsider the reasonable options for EUCOM, WESTCOM and FORSCOM.

2.2 Scenarios

Before the current effort began, it was thought that a review of Army conflict scenarios and/or War Games would be of great value in specifying operational environments and product lists. Accordingly, the SCORES scenarios were

reviewed and were found to be much too coarse. Entire Battalions were simply moved from one location to another and engaged in various broad categories of offensive and defensive activities. Engineer units were frequently used only for mine laying, and topographic support was tacitly taken for granted or ignored. However, the scenarios analysis did indicate that terrain analysis products would be of greatest value.

Seventeen reports on various Army (and DoD) wargaming activities were obtained from the Defense Technical Information Center and were carefully reviewed. They tended to fall into two categories; low resolution, broad scope simulations which were similar to the scenarios, and high resolution, narrow scope games, such as tank vs. tank battles or antiaircraft artillery vs. aircraft battles. Neither category was of any value in defining TSS variables.

2.3 DMA Inputs to TSS

The Defense Mapping Agency (DMA) will supply conventional maps to the field units. In addition, DMA will increasingly supply Terrain Analysis products. In the short term these will consist of completed products, such as Cross Country Movement, Lines of Communication, Lines of Sight, etc., and the underlying Factor Overlays.

In the longer term DMA will supply increasing numbers of digital files to some of its customers. Generally, these will be:

- Digital Terrain Elevation Data (DTED)
- Digital Feature Analysis Data (DFAD)
- Digital Terrain Analysis Data (DTAD)

DTED's are the common elevation matrices. These contain the data which are supplied for field system like FIREFINDER. DFAD's contain the location and characteristics of natural and man made features on the surface of the Earth. Features are water, vegetation, buildings, bridges, etc. etc. Among other things, DFAD's are used to drive radar and IR displays in flight simulators. DTAD's will contain all of the basic information necessary to produce any Terrain Analysis, such as tree stem spacing, diameter, type, etc. etc. One of the major users of digital data will be the Army's proposed Digital Topographic Support System (DTSS).

2.4 Product Request Lists

Discussions with personnel of the 649th Engineer Battalion, 29th Engineer Battalion and those elements of the 30th Engineer Battalion attached to XVIII Corps in general verified the 1978 Product List. It was determined that the 649th and 30th at Ft. Bragg have no suitable Imagery and hence cannot currently produce any Image Based Products. However, it was felt that, in time of crisis or conflict, source materials would be available. It was agreed that Terrain Analysis products, specifically updates to previously completed Terrain Analyses, were increasing in importance, while the time available to produce a useful product was decreasing. The operational personnel felt that only about two hours would be available to complete products required by the field commandere.

It was agreed that the Division Direct Support Module would produce almost nothing but Terrain Analysis products, and two hours would be the maximum time available. A daily intelligence briefing product might also be produced.

The products produced by the various support elements vary. Thus different product lists were developed for the five troop Terrain Team (All hasty Terrain Analysis products), the twenty-five troop Terrain Team (Mostly Terrain Analysis products, both hasty and more elegantly executed) and the Topographic Battallion (AllProducts).

2.5 Sensor Study

Shortly after the current contract was signed, the Contracting Officer's Technical Representative (COTR) was given an assignment to assess the impact of certain current and developmental sensors. This assignment had a very short term deadline. Under the "...work and services to be performed hereunder shall include but not necessarily be limited to..." clause in the Purchase Description, the contractor was assigned certain areas of investigation. Because the study was in a classified area, no details can be given here.

3. Revised Simulation

3.1 Introduction

Introducing the upgrades to the 1978 simulation by adding "patches" to the code produced programs that were very difficult to understand. Because the training of Government personnel in the use of the program was a major goal of this effort, this was very undesirable. For this reason, it was decided to rewrite the program, making it both easier to use and to understand. ETLSIM is the result of this rewrite.

3.2 ETLSIM Overview

ETLSIM is not a model of any particular system, but rather an environment which allows the user to conveniently and easily specify the nature for the system to be modelled. ETLSIM then builds the computer model, exercises it, and generates statistical reports for the user.

The ETLSIM simulation program is written in GPSS V (General Purpose Simulation System) and FORTRAN IV. The program has been installed and verified on the Cyber 170-730 computing system located at ETL.

3.3 General Description of Inputs, Processing and Outputs

The information flow of the ETLSIM program is presented in Figure 3-1. The user specifies the information on the left hand side of the figure. ETLSIM inputs these data, constructs a model which reflects the data set, and then exercises or runs that model for a length of time as requested by the user. A series of reports is produced which give statistics on the performance of each component specified.

The following three sections provide an overview of the inputs, processing and outputs of ETLSIM.

3.3.1 Inputs

The user input to ETLSIM consists of a description of the system to be

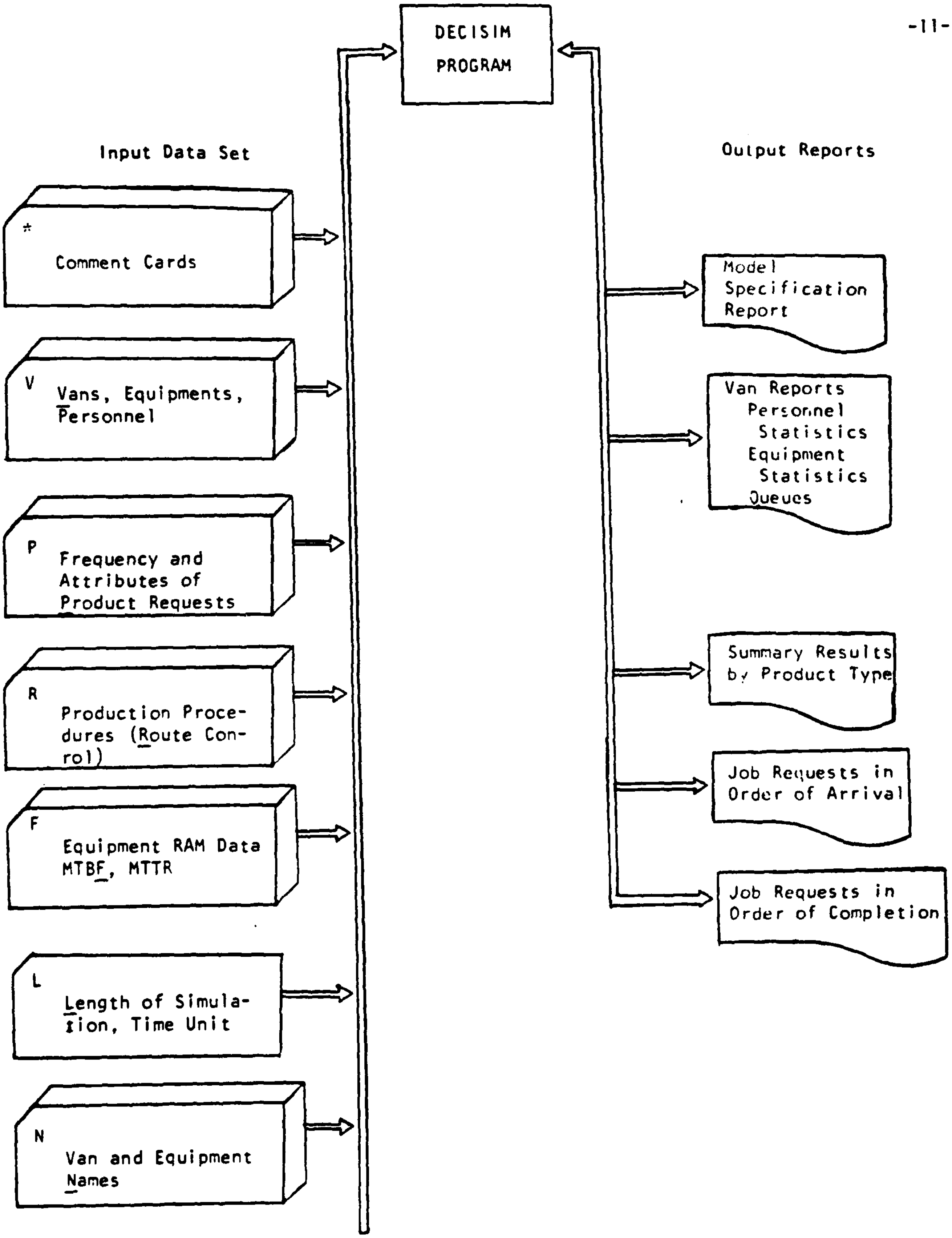

Figure 3-1 DECISIM Information Flow

modelled. This description includes the physical structure (number of vans, number of people per van, number and type of equipments per van, and equipment reliability data) as well as the system's mission (type, frequency, and attributes of anticipated product requests, and the production steps for each product type). Figure 3-2 shows the input data set used to model a single Direct Support Section.

The method that is used to input these data was designed to be convenient and easy for non-dataprocessing personnel. Each van is represented by a single data card image which describes its complement of personnel and equipment. A single data card image is also used to represent each particular type of product request, along with its frequency of occurrence and associated attributes (e.g. area coverage, priority). The remaining types of input information are entered in a similar manner.

The user is also given the capability of documenting the inptu data with comments. These may be used to specify the format of the input data (as a convenience to the user) as well as to print any additional information that might be of importance (e.g. critical assumptions). A copy of the entire input data set is then appended to the output reports, resulting in a complete record of each session.

3.3.2 Processing

The production system that is simulated by ETLSIM is a very dynamic, parallel operation. There are potentially large numbers of jobs in various stages of production at any given moment. New product requests keep arriving and competing for the fixed resources (personnel, equipment). Equipments periodically breakdown and require a varying amount of time to be repaired. Queues, or waiting lines, can develop at any piece of equipment at almost any time.

The first thing that ETLSIM does, after reading the input data, is model each van with the user specified personnel and equipment configuration. Job requests are then created based upon the frequencies that were input by the user.

```
DECISION MODEL SPECIFICATION CARDS          01/11/83         14.04.48.
*
* ================================
* DIVISION DIRECT SUPPORT DATA SET
* ================================
*
*
*  VAN   NBR OF    NUMBER OF EACH OF THE 9 POSSIBLE EQUIPMENT TYPES
*  NBR   PEOPLE    EQ1  EQ2  EQ3  EQ4  EQ5  EQ6  EQ7  EQ8  EQ9
*   XX     XX       XX   XX   XX   XX   XX   XX   XX   XX   XX
V    1      5        1    2    1    1    2    5
*
*
*
*  PRIMARY    SECONDARY RTE  AVG NBR OF                      -FUNCTION NUMBER FOR-
*  CATEGORY   CATEGORY  PCH  REQUESTS  IN XX DAYS    SPREAD    A    B    C    D    E
*     XX         XX      XX    XXX        XX           XX     XX   XX   XX   XX   XX
P     10          1       1     24         1            1      1    1   77   79    1
P     10          2       2      1         1            1      1    1    3   11    1
*
*
*
* LENGTH OF
* SIMULATION                         SIMULATION        RANDOM NUMBER
* SNAPSHOTS     NUMBER OF            TIME UNIT          GENERATION
* (IN DAYS)     SNAPSHOTS          (SEC,MIN,HRS)      (RANDOM,PSEUDO)
*    XX            XX                  XXX                XXXXXX
L     2             3                  SEC                RANDOM
*
*
*
*
*
*  ROUTE CONTROL MATRIX  (VVVEETTLL)
*
*  NUMBER OF ROWS
*        XX
R        02
          6
   1000000   1051911   1023611   1032711   1011124     10000
          7
   1000000   1063111   1051911   1023611   1032711   1011124     10000
*
*   VAN  EQUIP       MTBF
*   NBR   NBR       (HOURS)       MTTR  (SEC,MIN,HRS OF DAY)
*   XX    XX        XXXXXX       XXXXXX XXX
*
*  THERE ARE CURRENTLY NONE SPECIFIED.
*
$
*
*
* VAN/EQUIPMENT NAMES
*
* XX XX    XXXXXXXXXXXXXXXXXXXX
N  1       DIV DIRECT SUPPORT
N  1  1    DIAZO MACHINE
N  1  2    DRAFT/LGT TBL, SCOPE
N  1  3    TYPEWRITER
N  1  4    FACSIMILE MACHINE
N  1  5    STORAGE FILES
*
```

FIGURE 3-2

Each of these requests (actually a GPSS transaction) is assigned a set of attributes (e.g. area coverage, priority, number of copies of final product to be made). Each job request then examines the first entry in its assigned row of the Route Control Matrix (which contains the user specified production steps). This entry indicates which van and equipment is requried and specifies a time distribution (a GPSS FUNCTION) which will be sampled to determine the exact amount of time necessary to perform this step. The job then moves to the proper van and attempts to grab the specified piece of equipment as well as the personnel to operate it. Any conflicts that arise in attempts to obtain either personnel or equipment are arbitrated by ETLSIM based upon the priority of the competing jobs. Once the equipment has been used for the proper amount of time, the job then examines the next entry in the Route Control Matrix to determine where to go next. This procedure is repeated and jobs step through their production sequences until an entry in the matrix indicates that the product has been completed.

ETLSIM continues to create job requests and move them through the model until a user specified number of simulated days have elapsed. A complete set of statistical reports is then produced which allows the user to determine how well, or poorly, the system handled the demands made upon it.

3.3.3 Outputs

The output reports produced by ETLSIM fall into five categories. A copy of the entire input data set is output first, which gives the user a complete record of the model specification. A one page report is then produced for each van which gives a statistical summary of how that van was utilized during the simulation run (figure 3-3). Included in the report are how many jobs entered the van, how many jobs used each piece of equipment and whether or not they had to wait for equipments of personnel (and if so, where, and for how long). The utilization of the assigned personnel and equipments is listed along with equipment reliability statistics.

A summary report is produced that is organized by type of product request (figure 3-4). This indicates how many requests of each type of product occurred, how many were completed and the average production pipeline time and travel time (between vans).

DIV DIRECT SUPPORT

OVERALL VAN AND EQUIPMENT QUEUE STATISTICS

QUEUE NAME	MAXIMUM CONTENTS	AVERAGE CONTENTS	TOTAL ENTRIES	ZERO ENTRIES	PERCENT ZEROS	AVERAGE TIME/TRAN	$AVERAGE TIME/TRAN	CURRENT CONTENTS
DIV DIRECT SUPPORT	5	1.295	48	0	0.0	11863.188	11863.188	3
DIAZO MACHINE	1	0.000	45	45	100.0	0.000	0.000	0
DRAFT/LGT TBL, SCOPE	3	1.043	46	4	8.3	3753.729	4094.977	1
TYPEWRITER	1	.011	45	40	88.9	41.111	370.000	0
FACSIMILE MACHINE	NEVER USED							
STORAGE FILES	1	0.000	48	48	100.0	0.000	0.000	0

PERSONNEL STATISTICS

NUMBER IN VAN	AVERAGE NBR USED	AVERAGE UTILIZATION	NUMBER OF JOBS	AVERAGE TIME/JOB	NUMBER CURRENTLY OCCUPIED	MAXIMUM NUMBER OCCUPIED
5	2.246	.449	186	2086.817	2	5

EQUIPMENT STATISTICS

	NUMBER IN VAN	AVERAGE NBR USED	AVERAGE UTILIZATION -TOTAL- TIME	AVERAGE UTILIZATION -AVAILABLE- TIME	NUMBER OF JOBS	AVERAGE TIME/JOB	NUMBER CURRENTLY OCCUPIED	MAXIMUM NUMBER OCCUPIED	PERCENT OF TIME AVAILABLE
DIAZO MACHINE	1	.076	.076	.076	45	292.000	0	1	100.00
DRAFT/LGT TBL, SCOPE	2	1.849	.925	.925	47	6798.694	2	2	100.00
TYPEWRITER	1	.227	.227	.227	45	871.800	0	1	100.00
FACSIMILE MACHINE	1	NEVER USED							
STORAGE FILES	2	.065	.032	.032	48	233.542	0	1	100.00

FIGURE 3-3

SUMMARY RESULTS OF SIMULATION BY PRODUCT TYPE

PRIMARY CATEGORY	SECONDARY CATEGORY	RTE ROW	NUMBER OF ENTRIES	PERCENT OF TOTAL ENTRIES	NUMBER OF EXITS	PERCENT OF TOTAL EXITS	AVERAGE RESIDENCE (HOURS) (MIN)	AVERAGE TRAVEL TIME (HOURS) (MIN)
10	1	1	47	97.92	44	97.78	3 14	0 0
10	2	2	1	2.08	1	2.22	2 33	0 0

FIGURE 3-4

Two historical lists are maintained. The first is a list of product requests in the order in which they arrived (figure 3-5). The exact time of arrival and the value of each of the attributes is listed. The second is a list of product requests in the order in which they were completed (figure 3-6). In addition to the list of attributes, the arrival time, completion time, residence time and travel times for each job are printed.

JOB REQUESTS IN ORDER OF ARRIVAL

ARVL NBR	ENTRY TIME	(PRIM,SEC) CATEGORY	RTE ROW	NBR ITEMS	NOT USED	PRIORITY	NUMBER COPIES	NUMBER FRAMES
1	3602	(10, 1)	1	1	1	1	8	1
2	7202	(10, 1)	1	1	1	0	8	1
3	10802	(10, 1)	1	1	1	1	8	1
4	14402	(10, 1)	1	1	1	1	8	1
5	18002	(10, 1)	1	1	1	1	12	1
6	21602	(10, 1)	1	1	1	1	12	1
7	25202	(10, 1)	1	1	1	1	8	1
8	28802	(10, 1)	1	1	1	1	12	1
9	32402	(10, 1)	1	1	1	2	8	1
10	36002	(10, 1)	1	1	1	1	8	1
11	39602	(10, 1)	1	1	1	1	8	1
12	43202	(10, 1)	1	1	1	1	8	1
13	46802	(10, 1)	1	1	1	1	12	1
14	50402	(10, 1)	1	1	1	1	8	1
15	54002	(10, 1)	1	1	1	1	8	1
16	57602	(10, 1)	1	1	1	1	8	1
17	61202	(10, 1)	1	1	1	1	12	1
18	64802	(10, 1)	1	1	1	1	8	1
19	68402	(10, 1)	1	1	1	1	12	1
20	72002	(10, 1)	1	1	1	1	8	1
21	75602	(10, 1)	1	1	1	1	8	1
22	79202	(10, 1)	1	1	1	2	8	1
23	82802	(10, 1)	1	1	1	1	8	1
24	86402	(10, 2)	2	1	1	3	30	1
25	86402	(10, 1)	1	1	1	1	12	1
26	90002	(10, 1)	1	1	1	1	12	1
27	93602	(10, 1)	1	1	1	1	8	1
28	97202	(10, 1)	1	1	1	1	12	1
29	100802	(10, 1)	1	1	1	1	8	1
30	104402	(10, 1)	1	1	1	1	8	1
31	108002	(10, 1)	1	1	1	1	8	1
32	111602	(10, 1)	1	1	1	1	8	1
33	115202	(10, 1)	1	1	1	1	8	1
34	118802	(10, 1)	1	1	1	1	8	1
35	122402	(10, 1)	1	1	1	2	12	1
36	126002	(10, 1)	1	1	1	1	8	1
37	129602	(10, 1)	1	1	1	1	12	1
38	133202	(10, 1)	1	1	1	1	8	1
39	136802	(10, 1)	1	1	1	1	8	1
40	140402	(10, 1)	1	1	1	1	12	1
41	144002	(10, 1)	1	1	1	1	8	1
42	147602	(10, 1)	1	1	1	1	8	1
43	151202	(10, 1)	1	1	1	1	12	1
44	154802	(10, 1)	1	1	1	1	12	1
45	158402	(10, 1)	1	1	1	1	8	1
46	162002	(10, 1)	1	1	1	1	8	1
47	165602	(10, 1)	1	1	1	1	8	1
48	169202	(10, 1)	1	1	1	1	8	1

FIGURE 3-5

JOB REQUESTS IN ORDER OF COMPLETION

ARVL NBR	EXIT TIME	(PRIM,SEC) CATEGORY	RTE POW	NBR ITEMS	NOT USED	PRIO RITY	NUMBER COPIES	NUMBER FRAMES	ENTRY TIME	EXIT TIME	RESIDENCE TIME	TRAVEL TIME
1	12969	(10, 1)	1	1	1	1	8	1	1HRS , 0MIN	3HRS ,36MIN	2HRS ,36MIN	0HRS , 0MIN
2	13736	(10, 1)	1	1	1	0	8	1	2HRS , 0MIN	3HRS ,49MIN	1HRS ,49MIN	0HRS , 0MIN
3	16650	(10, 1)	1	1	1	1	8	1	3HRS , 0MIN	4HRS ,38MIN	1HRS ,37MIN	0HRS , 0MIN
4	23426	(10, 1)	1	1	1	1	8	1	4HRS , 0MIN	6HRS ,30MIN	2HRS ,30MIN	0HRS , 0MIN
5	28043	(10, 1)	1	1	1	1	12	1	5HRS , 0MIN	7HRS ,47MIN	2HRS ,47MIN	0HRS , 0MIN
6	31178	(10, 1)	1	1	1	1	12	1	6HRS , 0MIN	8HRS ,40MIN	2HRS ,40MIN	0HRS , 0MIN
7	36192	(10, 1)	1	1	1	1	8	1	7HRS , 0MIN	10HRS , 3MIN	3HRS , 3MIN	0HRS , 0MIN
8	38058	(10, 1)	1	1	1	1	12	1	8HRS , 0MIN	10HRS ,34MIN	2HRS ,34MIN	0HRS , 0MIN
9	43926	(10, 1)	1	1	1	2	8	1	9HRS , 0MIN	12HRS ,12MIN	3HRS ,12MIN	0HRS , 0MIN
10	47774	(10, 1)	1	1	1	1	8	1	10HRS , 0MIN	13HRS ,15MIN	3HRS ,15MIN	0HRS , 0MIN
11	53572	(10, 1)	1	1	1	1	8	1	11HRS , 0MIN	14HRS ,53MIN	3HRS ,53MIN	0HRS , 0MIN
12	57069	(10, 1)	1	1	1	1	8	1	12HRS , 0MIN	15HRS ,51MIN	3HRS ,51MIN	0HRS , 0MIN
13	58266	(10, 1)	1	1	1	1	12	1	13HRS , 0MIN	16HRS ,11MIN	3HRS ,11MIN	0HRS , 0MIN
14	61337	(10, 1)	1	1	1	1	8	1	14HRS , 0MIN	17HRS , 2MIN	3HRS , 2MIN	0HRS , 0MIN
15	67491	(10, 1)	1	1	1	1	8	1	15HRS , 0MIN	18HRS ,45MIN	3HRS ,45MIN	0HRS , 0MIN
16	72032	(10, 1)	1	1	1	1	8	1	16HRS , 0MIN	20HRS , 1MIN	4HRS , 1MIN	0HRS , 0MIN
17	77621	(10, 1)	1	1	1	1	12	1	17HRS , 0MIN	21HRS ,34MIN	4HRS ,34MIN	0HRS , 0MIN
18	78356	(10, 1)	1	1	1	1	8	1	18HRS , 0MIN	21HRS ,46MIN	3HRS ,46MIN	0HRS , 0MIN
20	82377	(10, 1)	1	1	1	1	8	1	20HRS , 0MIN	22HRS ,53MIN	2HRS ,53MIN	0HRS , 0MIN
19	83328	(10, 1)	1	1	1	1	12	1	19HRS , 0MIN	23HRS , 9MIN	4HRS , 9MIN	0HRS , 0MIN
21	86962	(10, 1)	1	1	1	1	8	1	21HRS , 0MIN	24HRS , 9MIN	3HRS , 9MIN	0HRS , 0MIN
22	89716	(10, 1)	1	1	1	2	8	1	22HRS , 0MIN	24HRS ,55MIN	2HRS ,55MIN	0HRS , 0MIN
24	95592	(10, 2)	2	1	1	3	30	1	24HRS , 0MIN	26HRS ,33MIN	2HRS ,33MIN	0HRS , 0MIN
23	96825	(10, 1)	1	1	1	1	8	1	23HRS , 0MIN	26HRS ,54MIN	3HRS ,54MIN	0HRS , 0MIN
26	103557	(10, 1)	1	1	1	1	12	1	25HRS , 0MIN	28HRS ,46MIN	3HRS ,46MIN	0HRS , 0MIN
25	104897	(10, 1)	1	1	1	1	12	1	24HRS , 0MIN	29HRS , 8MIN	5HRS , 8MIN	0HRS , 0MIN
27	108211	(10, 1)	1	1	1	1	8	1	26HRS , 0MIN	30HRS , 4MIN	4HRS , 3MIN	0HRS , 0MIN
28	113662	(10, 1)	1	1	1	1	12	1	27HRS , 0MIN	31HRS ,34MIN	4HRS ,34MIN	0HRS , 0MIN
29	114892	(10, 1)	1	1	1	1	8	1	28HRS , 0MIN	31HRS ,55MIN	3HRS ,55MIN	0HRS , 0MIN
30	118133	(10, 1)	1	1	1	1	8	1	29HRS , 0MIN	32HRS ,49MIN	3HRS ,49MIN	0HRS , 0MIN
31	118841	(10, 1)	1	1	1	1	8	1	30HRS , 0MIN	33HRS , 1MIN	3HRS , 1MIN	0HRS , 0MIN
33	126864	(10, 1)	1	1	1	1	8	1	32HRS , 0MIN	35HRS ,24MIN	3HRS ,14MIN	0HRS , 0MIN
32	127996	(10, 1)	1	1	1	1	8	1	31HRS , 0MIN	35HRS ,33MIN	4HRS ,33MIN	0HRS , 0MIN
34	131900	(10, 1)	1	1	1	1	8	1	33HRS , 0MIN	36HRS ,38MIN	3HRS ,38MIN	0HRS , 0MIN
35	134507	(10, 1)	1	1	1	2	12	1	34HRS , 0MIN	37HRS ,22MIN	3HRS ,22MIN	0HRS , 0MIN
36	140245	(10, 1)	1	1	1	1	8	1	35HRS , 0MIN	38HRS ,57MIN	3HRS ,57MIN	0HRS , 0MIN
37	144578	(10, 1)	1	1	1	1	12	1	36HRS , 0MIN	40HRS ,10MIN	4HRS ,10MIN	0HRS , 0MIN
38	148603	(10, 1)	1	1	1	1	8	1	37HRS , 0MIN	41HRS ,17MIN	4HRS ,17MIN	0HRS , 0MIN
39	149675	(10, 1)	1	1	1	1	8	1	38HRS , 0MIN	41HRS ,37MIN	3HRS ,37MIN	0HRS , 0MIN
41	154153	(10, 1)	1	1	1	1	8	1	40HRS , 0MIN	42HRS ,49MIN	2HRS ,49MIN	0HRS , 0MIN
40	155441	(10, 1)	1	1	1	1	12	1	39HRS , 0MIN	43HRS ,11MIN	4HRS ,11MIN	0HRS , 0MIN
41	160379	(10, 1)	1	1	1	1	12	1	42HRS , 0MIN	44HRS ,33MIN	2HRS ,33MIN	0HRS , 0MIN
42	164859	(10, 1)	1	1	1	1	8	1	41HRS , 0MIN	45HRS ,48MIN	4HRS ,48MIN	0HRS , 0MIN
44	166470	(10, 1)	1	1	1	1	12	1	43HRS , 0MIN	46HRS ,15MIN	3HRS ,14MIN	0HRS , 0MIN
45	168682	(10, 1)	1	1	1	1	8	1	44HRS , 0MIN	46HRS ,51MIN	2HRS ,51MIN	0HRS , 0MIN

FIGURE 3-6

4. Model Validation

Since new capabilities were built into the model, test cases were run to verify the proper implementation of these capabilities. In all, the following validation tests were run:

- alternate path processing
- user ability to specify personnel assignments and equipment configurations within a van.
- proper handling of equipment RAM inputs
- user ability to select one of three time units (seconds, minutes, or hours) for the simulation.
- random and pseudo-random number generators
- statistical report generation

4.1 Model Verification

Since an entirely new simulation system was created, the 1978 results provided a convenient method of program verification. Results of five "new" topographic support simulations were compared with those from the 1978 simulations. A comparison of Twenty randomly selected statistics from the 1978 Model and ETLISM results was made. The Mann Whitney test* of two independent samples was used. No differences were observed between the results from the ETLISM version and from the 1978 version. Since both produced the same results, on average, it is concluded that ETLISM is verified.

*Due to the small number of samples (5) only non-parametric statistics are appropriate. For a discussion of the Mann-Whitney test, see Siegel, Sidney Non-Parametric Statistics, McGraw-Hill, 1956, p. 116.

5 Results of Experiments

In July 1983 ETLSIM was used for the first time to provide information to a decision making group. The occasion was the preliminary Required Operational Capability (ROC) review for the Quick Response Multicolor Printer (QRMP). There was a proposal at that time that the entire Reproduction Subsystem of the Topographic Support System (TSS) could be eliminated when the QRMP became available. The scenario used for the experiment was a Terrain Team and a Cartographic Company, co-located at corps, without the Direct Support Vehicle. The simulation length was six twenty four hour days to approximate the beginning phase of a high intensity conflict. Thirty eight different types of product requests were generated, ranging from a simple verbal request for information to the preparation of an uncontrolled photomosaic.

Two separate simulations were computed, one with a QRMP van attached, and one limited to the standard Reproduction Subsystem. An analysis of the results indicated that even those products which were reproduced using the QRMP frequently used elements within the Reproduction Subsystem, such as the Camera and Layout Vans. The controlling factor was, of course, the product request list. A standard list which had been used during the development of ETLSIM was adopted. It became clear that when the QRMP becomes available for introduction into the field units it will impose conditions upon the types and numbers of products produced. Since this was the first experiment, each run was repeated five times to eliminate the possibility of a statistical outlier affecting the results. The major conclusion was that merely introducing the QRMP and leaving all of the other elements in place will not alter the basic makeup of the organization. The equipment utilization statistics confirmed that, for these two simulations, two QRMP's could replace two offset presses. All other equipment would have to be retained.

The second series of experiments concerned QRMP design criteria. There has been controversy concerning the optimum value for the Mean Time Before Failure (MTBF) for the QRMP. Candidate values ranged from 170 to 310 hours at the time the simulations were initiated. The scenario chosen was a three month period, during which the unit would be working a one shift operation, seven days a week. Rather than use the entire Carto Company, a Terrain Team with a QRMP attached was selected as the subject of the simulations. Eighteen products were selected, ranging from a simple request for information to the preparation

of a special purpose overlay from basic source material. All of the products except the verbal requests for information were routed through the QRMP. The product descriptions are in the following Section 5.

The first part is a description of the product type, some examples, and a brief discussion of the process specified for its preparation. This is followed by a description of the times required for the various production steps. These are given only as examples to aid in analysis. Actually these values are the means of probability distributions which will be sampled by the computer during the actual simulations. The total lapsed time from the request to the delivery to the customer, discussed in this part, includes the travel time between vans.

The second part of the product list serves to assign numbers which can be understood by the ETLSIM program to the various van and equipment names, to the time function which is a variable that determines how long the equipment will be used, and to the loop value which is a variable that determines the number of times the particular piece of equipment will be used.

The third part of the descriptions is the row of the actual ETLSIM Route Control Matrix, derived from the previous two parts, which is the input for the simulation. A more detailed description of these elements are contained in Volume I of the ETLSIM User's/Maintenance Manual.

Initially six simulations were rushed to provide information for the QRMP Test Integration Working Group (TIWG), which met during 5-6 September 1984. Six values for MTBF were used in these, which spanned the proposed values. A Mean Time To Repair (MTTR) of eight hours was used throughout. The results of these indicated that little would be gained by lengthening the MTBF beyond a point somewhere between 150 and 200 hours. Additional follow-on experiments were conducted to verify these conclusions, with the request rate increased by 150% to stress the system. These results exhibited the same general trends, however, the Weighted Average Pipeline Time (WAPT) computed from the resulting summary statistics had too large a range to draw firm conclusions. Also the response time increased from the optimum goal of two hours by a factor of approximately ten. It was necessary to revert to the normal expected product request rate; and rather than permit the products to be selected from a gaussian distribution, as was done with the preliminary simulations, the MTBF input

was constrained to specific values, and simulations with 28 different values for MTBF were computed. A minimum of three simulations per MTBF value were computed to eliminate statistical outliers. As many as seven replications were performed for an individual MTBF value, for a grand total of 78 separate simulations.

A plot of the WAPT against MTBF is shown in figure one. It exhibits the same trend which was previously reported to the TIWG. The WAPT decreases regularly during the progressive increase in MTBF from 50 to about 165 hours, from about three and a half hours to less than two hours. It then took an unexpected jump between 175 and 200 hours, settling down again to less than two hours. Numerically this is not significant since it indicates only a six minute variation in WAPT over a total range of approximately two hours. This is only five percent. The variations in individual computed WAPT values from simulations with the identical MTBF at times exceeds this variation by 100%. This might have been caused by assigning specific values of MTBF rather than have the computer generate them. Additional simulations should be performed to determine the cause and eliminate it from future experiments.

Figure two was obtained by averaging the various WAPT values for the same value of MTBF. Although it again shows the jump between 175 and 200 hours, it also confirms the previous conclusions. Based on this scenario, with this particular product list, and at these specified request rates; it can be forecast that increasing the MTBF beyond 165 hours will not affect the productivity of the system. Other scenarios, product lists, and request rates need to be simulated before these conclusions can be translated into design parameters for a fabrication contract, but these experiments clearly indicate the potential role of simulations during developmental activities.

These experiments serve to illustrate the flexibility of ETLSIM in problem solving. In the first instance the equipment utilization statistics were the basis for analysis. In the second experiment manpower utilization statistics were used; and finally, for the evaluation of various values of MTTF for the QRMP, the product summary statistics were used to compute the WAPT.

Future plans include performing additional simulations of Topographic field units which will have a QRMP, to include variations in MTTR as well

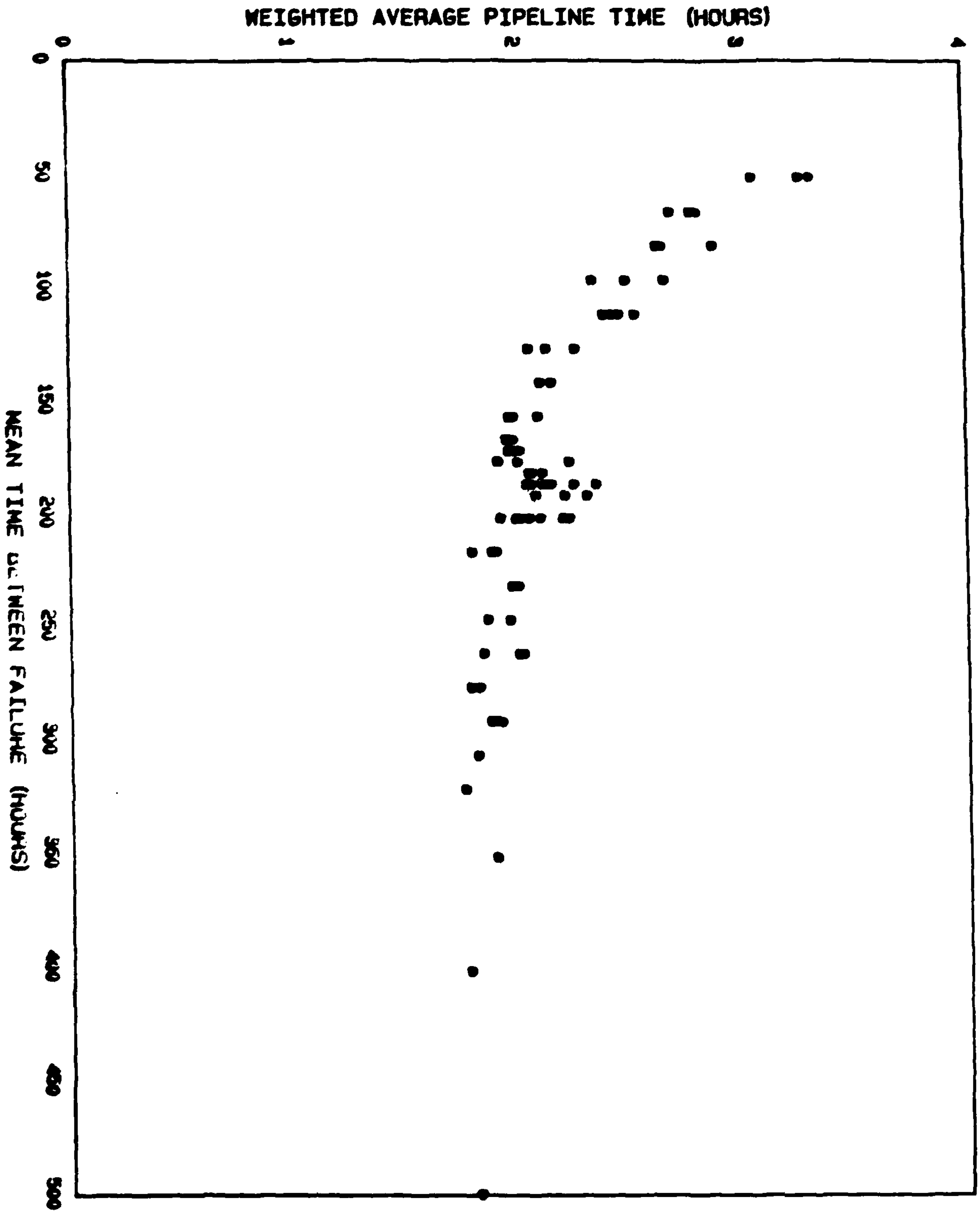
WEIGHTED AVERAGE PIPELINE TIME (HOURS)
0
1
2
3
4
0
50
100
150
200
250
300
350
400
450
500
MEAN TIME BETWEEN FAILURE (HOURS)

FIGURE 1

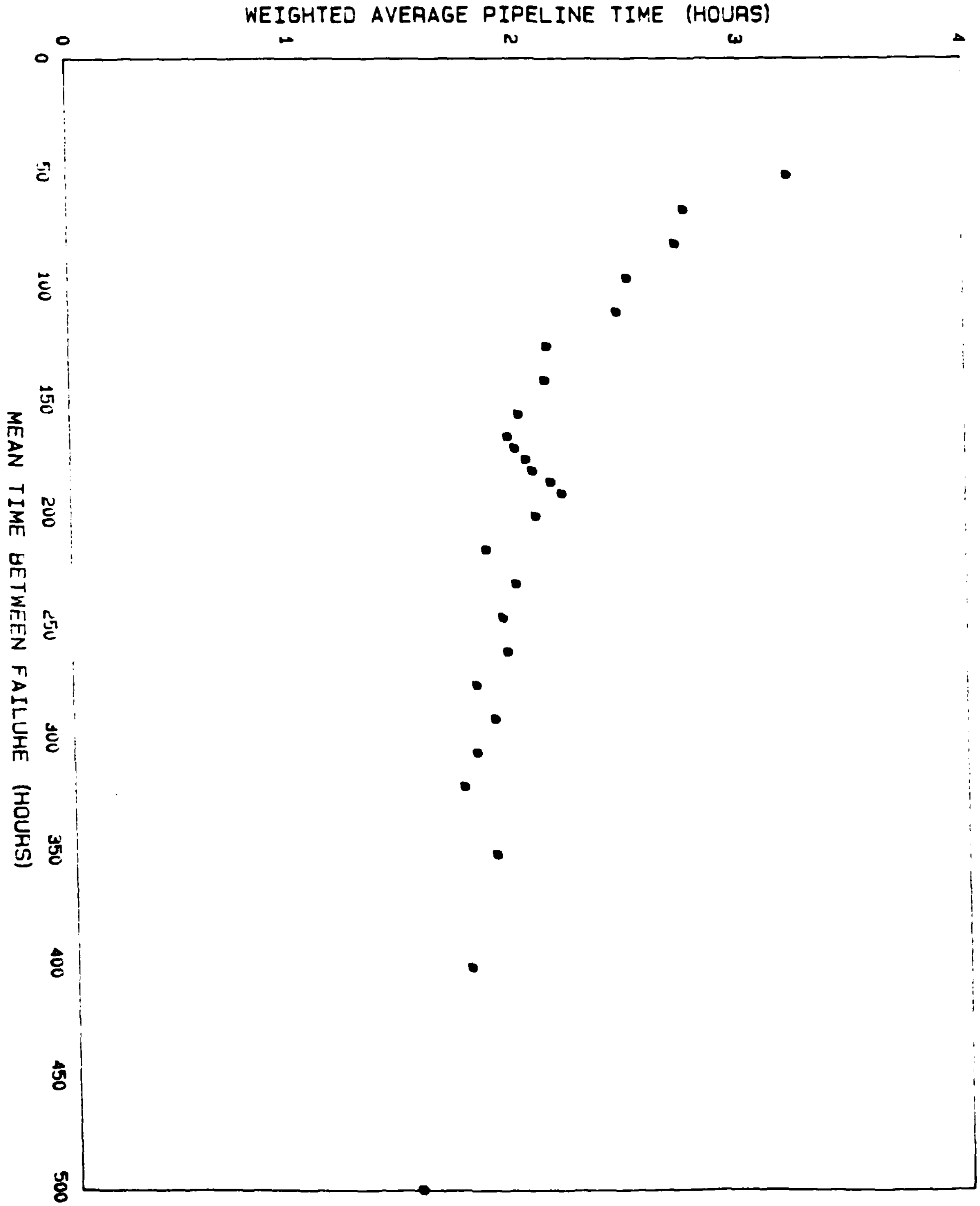
WEIGHTED AVERAGE PIPELINE TIME (HOURS)
0
1
2
3
4
MEAN TIME BETWEEN FAILURE (HOURS)
0
50
100
150
200
250
300
350
400
450
500

FIGURE 2

as MTBF values. Actions to simulate the Digital Topographic Support System (DTSS) will also be initiated. As more varied simulations are accomplished, design criteria can be forecast more accurately, which will help to eliminate the expenses of overdesigning, or gold plating, while guaranteeing that the resulting items of equipment will function effectively in their own environment.

6 Terrain Team Corps Level with QRMP

Product 1-1

Standard Map Sheet Overprinted with Existing Overlay

This product will probably be requested more than any other, especially during emergencies when a quick response is essential to field operations. The process is to obtain a standard map sheet and an existing overlay from stock, register them together and reproduce the combined product on the QRMP. About 10 minutes is required for the individual in the Terrain Team Headquarters to clarify the order with the customer, and an additional five minutes after it is completed for inspection and distribution. Searching the card files and drawing the required documents will use another six minutes. Preparation and reproduction in the QRMP Van will take seven minutes. The product will physically travel between three vans, taking 12 minutes. Using these values the total lapsed time from request to delivery will be 40 minutes. The cumulative effect of sampling time distributions and delays caused by queues and equipment failures are not included in this estimate.

Process

Van		Equipment		Time		Loop	
Number	Name	Number	Name	Number	Value	Number	Value
9	HQ	01	Server	70	600*Exp	01	1
4	Information						
		01	Rolodex	17	180±60	11	Attribute A
		02	File	17	180±60	11	Attribute A
25	QRMP						
		02	QRMP	61	300±23/Cy	11	Attribute A
		02	QRMP	61	300=23/Cy	11	Attribute A
9	HQ	01	Server	21	300±60	01	1

ETLSIM Route control Matrix

9017001 4011711 4021711 25026111 25026111 9012101

7. Terrain Team Corps Level, with QRMP
Product 1-2, 1-3, and 1-4
Standard Map Sheet Overprinted with an Overlay Compiled From Two or More Existing Overlays

This product will be produced when two or more overlays are used to compile a special overlay for overprinting on a standard map sheet. An example would be a cross country movement graphic which requires certain elements from a vegetation overlay and from a hydrographic overlay. The new overlay will be combined with the standard map and reproduced using the QRMP. Additional production flexibility is provided by having the final overlay prepared using the light tables from either the Analysis or Synthesis Vans. Headquarters will require 10 minutes to accept and assign the work, and five minutes after completion for inspection and distribution. Locating and obtaining the source overlays will take six minutes. The only difference between the three products is in the level of difficulty encountered in their preparation. This can result from a number of causes, e.g., degrees of complexity of the source overlays, the number of source overlays required, etc. A medium difficulty product will require three times the compilation effort of a low difficulty product, and one with a high degree of difficulty will require five times the effort. One hour is the time unit assigned to a product with a low level of difficulty. The level of difficulty will be assigned by the computer, with the times distributed uniformly. QRMP preparation and reproduction will require seven minutes. The product will move between vans four times, for a total time of 16 minutes. Therefore, the total production time will range between an hour and 44 minutes and five hours and 44 minutes, exclusive of any waiting time, or of delays caused by equipment failure.

Process

Van		Equipment		Time		Loop	
Number	Name	Number	Name	Number	Value	Number	Value
9	HQ	01	Server	70	600*Exp	01	1
4	Information						
		01	Rolodex	17	180$\pm$60	11	Attribute A
		02	File	17	180$\pm$60	11	Attribute A
0	Alternate Path	-4	Alternate Path Matrix (Tables)	82	Decision Function	*	*
25	QRMP						
		01	Table	13	120$\pm$15	11	Attribute A
		02	QRMP	61	300+23/Cy	11	Attribute A
9	HQ	01	Server	21	300$\pm$60	1	1

*Note

Low Difficulty	33	3600±1200	11	Attribute A
Medium Difficulty	33	3600±1200	13	Attribute A
High Difficulty	33	3600±1200	15	Attribute A

ETLSIM Route control Matricies

9017001	4011711	4021711	-48211	25011311	25026111	9012101
9017001	4011711	4021711	-48213	25011311	25026111	9012101
9017001	4011711	4021711	-48215	25011311	25026111	9012101

8. Terrain Team Corps Level, with QRMP

Product 1-5

Standard Map Sheet Overprinted with Existing Overlay with Auxillary Data on the Reverse Side

This product will be requested when more detailed information is required to supplement the overprinted map. Some examples could be economic and political information, perspective views from various vantage points, descriptions of medical facilities and food supplies keyed to the graphic, etc. The process is to obtain a standard map sheet, an existing overlay from stock, and the specified backup copy, register them together and reproduce the combined product using two operations of the QRMP. Ten minutes is required for the individual in the Terrain Team Headquarters to clarify the order with the customer, and an additional five minutes after it is completed for inspection and distribution. Searching the card files and drawing the required documents will use another six minutes. Two loops (one for each side of the Product Sheet(s)) through the QRMP will take 12 minutes. The product will physically travel between three vans, taking 12 minutes. The total production time will be 45 minutes. The cumulative effect of sampling time distributions and delays caused by queues and euqipment failures must be added to this value.

Process

Van		Equipment		Time		Loop	
Number	Name	Number	Name	Number	Value	Number	Value
9	HQ	01	Server	70	600*Exp	01	1
4	Information						
		01	Rolodex	17	180±60	11	Attribute A
		02	File	17	180±60	11	Attribute A
25	QRMP						
		01	Table	13	120±15	11	Attribute A
		02	QRMP	61	300+23/Cy	11	Attribute A
		02	QRMP	61	300+23/Cy	11	Attribute A
9	HQ	01	Server	21	300±60	01	1

ETLSIM Route control Matrix

9017001 4011711 4021711 25011311 25026111 25026111 9012101

9. Terrain Team Corps Level, with QRMP
Product 2-1
Standard Map Sheet and Separate Overlay

This product will be required when the information is too detailed to overprint on a standard map without causing confusion. The process is to obtain a standard map sheet and an existing overlay from stock and reproduce them individually using two operations of the QRMP. Terrain Team Headquarters will need ten minutes to clarify the order with the customer, and an additional five minutes after it is completed for inspection and distribution. Searching the card files and drawing the required documents will use another six minutes. Two loops through the QRMP without any preparation time will take ten minutes. The product will physically travel between three vans, taking 12 minutes. The total production time will be 40 minutes. The cumulative effect of sampling time distributions and delays caused by queues and equipment failures will cause the total lapsed time from request to delviery to increase this time considerably.

Process

Van		Equipment		Time		Loop	
Number	Name	Number	Name	Number	Value	Number	Value
9	HQ	01	Server	70	600*Exp	01	1
4	Information						
		01	Rolodex	17	180±60	11	Attribute A
		02	File	17	180±60	11	Attribute A
25	QRMP						
		02	QRMP	61	300+23/Cy	11	Attribute A
		02	QRMP	61	300+23/Cy	11	Attribute A
9	HQ	01	Server	21	300±60	01	1

ETLSIM Route control Matrix

9017001 4011711 4021711 25026111 25026111 9012101

10. Terrain Team Corps Level, with QRMP

Product 2-2,2-3, and 2-4

Standard Map Sheet and a Separate Overlay Compiled From Two or More Existing Overlays

This product will be produced when two or more overlays are used to compile a special overlay to be used in conjunction with a standard map sheet. It will be required when the information is too detailed to overprint without causing confusion. The new overlay and the standard map will be reproduced separately using the QRMP. Additional production flexibility is provided by having the final overlay prepared using the light tables from either the Analysis or Synthesis Vans. Headquarters will require 10 minutes to accept and assign the work, and five minutes after completion for inspection and distribution. Locating and obtaining the source overlays will take six minutes. The only difference between the three products is in the level of difficulty encountered in their preparation. This can result from a number of causes, e.g., degrees of complexity of the source overlays, the number of source overlays required, etc. A medium difficulty product will require three times the compilation effort of a low difficulty product, and one with a high degree of difficulty will require five times the effort. One hour is the time unit assigned to a product with a low level of difficulty. The level of difficulty will be assigned by the computer, with the times distributed uniformly. The product will move between vans four times, for a total time of 16 minutes. Therefore, the total production time will range between an hour and 37 minutes and five hours and 27 minutes, exclusive of variations in the values above caused by the sampling process, by the inclusion of waiting time, or of delays caused by equipment failure.

Process

Van		Equipment		Time		Loop	
Number	Name	Number	Name	Number	Value	Number	Loop
9	HQ	01	Server	70	600*Exp	01	1
4	Information						
		01	Rolodex	17	180+60	11	Attribute A
		02	File	17	180 ± 60	11	Attribute A
0	Alternate Path	-4	Alternate Path Matrix (Tables)	82	Decision Function	*	*

25	QRMP						
		02	QRMP	61	300±23/Cy	11	Attribute A
		02	QRMP	61	300±23/Cy	11	Attribute A
9	HQ	01	Server	21	300±60	01	1
		Low Difficulty		33	3600±1200	11	Attribute A
		Medium Difficulty		33	3600±1200	13	Attribute A
		High Difficulty		33	3600±1200	15	Attribute A

ETLSIM Route control Matrix

9017001	4011711	4021711	-48211	25026111	25026111	9012101
9017001	4011711	4021711	-48213	25026111	25026111	9012101
9017001	4011711	4021711	-48215	25026111	25026111	9012101

11. Terrain Team Corps Level, with QRMP

Product 3-1

Photographs From Basic Stocks

This product will be requested very often, especially during emergencies when a quick response is essential to field operations. The process is simply to obtain the source material, in this case a film positive, negative, or existing print and reproduce the required copies using the QRMP. About 10 minutes is required for the individual in the Terrain Team Headquarters to clarify the order with the customer, and an additional five minutes after it is completed for inspection and distribution. Searching the card files and extracting the required source materials will use another six minutes. Preparation and reproduction in the QRMP Van will take seven minutes. The product will physically travel between vans three times, using another 12 minutes. Using these values the total lapsed time from request to delivery will be 40 minutes. The cumulative effect of sampling time distributions and delays caused by queues and equipment failures are not included.

Process

Van		Equipment		Time		Loop	
Number	Name	Number	Name	Number	Value	Number	Value
9	HQ	01	Server	70	600*Exp	01	1
4	Information						
		01	Rolodex	17	180+60	11	Attribute A
		02	File	17	180±60	11	Attribute A
25	QRMP						
		01	Table	13	120+15	11	Attribute A
		02	QRMP	61	300±23/Cy	11	Attribute A
9	HQ	01	Server	21	300±60	01	1

ETLSIM Route control Matrix

9017001 4011711 4021711 25011311 25026111 9012101

12. Terrain Team Corps Level, with QRMP
Product 3-2, 3-3, and 3-4
Uncontrolled Photomosaic from Existing Material

This product will be produced when it is requested and there are a sufficient number of photographs, film positives, or negatives, on-hand, to cover the area required by the field Commander. Headquarters will require 10 minutes to accept and assign the work, and five minutes after completion for quality control and distribution. Locating and obtaining the photographic sources will take six minutes. The QRMP will make copies of the required photographs in five minutes. Production flexibility is provided here by allowing the product to be worked on at the light tables in either the Analysis of Synthesis Vans. The difference between the three products is in the level of difficulty encountered in their preparation. This can result form a number of causes, e.g., the number of photographs, the relative relief of the area, the density of ground control points, etc. A product of moderate (Medium) difficulty will require three times the effort of a easy (Low) product, and one with a high degree of difficulty will require five times the effort. One hour is the time unit assigned to an easy product. The level of difficulty will be assigned by the computer, with the times distributed uniformly. Returning to the QRMP Van, preparation and reproduction will require seven minutes. The product will move between vans five times, for a total time of 20 minutes. Therefore, the total production time for the three products will range between an hour and 53 minutes and five hours and 53 minutes, exclusive of any waiting time, or of delays caused by equipment failure.

Process

Van		Equipment		Time		Loop	
Number	Name	Number	Name	Number	Value	Number	Value
9	HQ	01	Server	70	600*Exp	01	1
4	Information						
		01	Rolodex	17	180+60	11	Attribute A
		02	File	17	180$\pm$60	11	Attribute A
25	QRMP	02	QRMP	21	300$\pm$60	11	Attribute A
0	Alternate Path	-4	Alternate Path Matrix (Tables)	82	Decision Function	*	*

25	QRMP						
		01	Table	13	120+15	11	Attribute A
		02	QRMP	61	300±23/Cy	11	Attribute A
9	HQ	01	Server	21	300±60	01	1

* Note:

Low Difficulty	33	3600+1200	11	Attribute A
Medium Difficulty	33	3600±1200	13	Attribute A
High Difficulty	33	3600±1200	15	Attribute A

ETLSIM Route control Matricies

9017001	4011711	4021711	25022111	-48211	25011311	25026111	9012101
9017001	4011711	4021711	25022111	-48213	25011311	25026111	9012101
9017001	4011711	4021711	25022111	-48215	25011311	25026111	9012101

13. Terrain Team Corps Level, with QRMP
Product 3-5, 3-6, and 3-7
Annotated Photographs from Existing Material

This product will be produced when there are a number of recently acquired up-to-date photographs on-hand of the area required by the field Commander. Headquarters will require 10 minutes to accept and assign the work, and five minutes after completion for quality control and distribution. Locating and obtaining the photographic sources will take six minutes. The QRMP will make copies of the required photographs in five minutes. Production flexibility is provided by allowing the product to be worked on at the light tables in either the Analysis or Synthesis Vans. The difference between the three products is in the level of difficulty encountered in their preparation. This can result from a number of causes, e.g., the number of photographs, the complexity of planimetric data, the amount of data from other sources to be plotted on the photographs, etc. A product of moderate (Medium) difficulty will require three times the effort of a easy (Low) product, and one with a high degree of difficulty will require five times the effort. One hour is the time unit assigned to an easy product. The level of difficulty will be assigned by the computer, with the times distributed uniformly. Returning to the QRMP Van, preparation and reproduction will require seven minutes. The product will move between vans five times, for a total time of 20 minutes. Therefore, the total production time for the three products will range between an hour and 53 minutes and five hours and 53 minutes, exclusive of any waiting time, or of delays caused by equipment failure.

Process

Van		Equipment		Time		Loop	
Number	Name	Number	Name	Number	Value	Number	Value
9	HQ	01	Server	70	600*Exp	01	1
4	Information						
		01	Rolodex	17	180+60	11	Attribute A
		02	File	17	180±60	11	Attribute A
25	QRMP	02	QRMP	21	300±60	11	Attribute A
0	Alternate Path	-4	Alternate Path Matrix (Tables)	82	Decision Function	*	*

25	QRMP						
		01	Table	13	120±15	11	Attribute A
		02	QRMP	61	300±23/Cy	11	Attribute A
9	HQ	01	Server	21	300±60	01	1

*Note:

Low Difficulty	33	3600+1200	11	Attribute A
Medium Difficulty	33	3600±1200	13	Attribute A
High Difficulty	33	3600±1200	15	Attribute A

ETLSIM Route control Matricies

9017001	4011711	4021711	25022111	-48211	25011311	25026111	9012101
9017001	4011711	4021711	25022111	-48213	25011311	25026111	9012101
9017001	4011711	4021711	25022111	-48215	25011311	25026111	9012101

14. Terrain Team Corps Level, with QRMP

Product 5-1

Verbal Information

This action will occur more frequently than any other, especially during emergencies when an immediate response is essential to field operations. Examples could be to determine whether or not essential bridges were still in place, or the effect of last nights weather on the dirt roads shown on yesterday afternoon's movement graphic. The process is simple, the individual in headquarters will accept the query, answer it fi the information is readily available to him, or will call the appropriate element to obtain the information if it is not. The estimated time for this is 35 minutes.

Process

Van		Equipment		Time		Loop	
Number	Name	Number	Name	Number	Value	Number	Value
9	HQ	01	Server	71	2100*Exp	01	1

ETLSIM Route Control Matrix

9017101

15. Terrain Team Corps Level, with QRMP
Product 8-1
Copies of Standard Map Sheets

This product will be produced either when there is not time to compile additional information or when it is not available within the Terrain Team. The process is to obtain a standard map sheet from stock and reproduce it in the required quantities using the QRMP. Ten minutes is required for the individual in the Terrain Team Headquarters to accept the order from the customer, and an additional five minutes after it is completed for inspection and distribution. Searching the card files and drawing the required documents will use another six minutes. The QRMP will take seven minutes. The product will physically travel between three vans, taking 12 minutes. The total production time will be 40 minutes. The cumulative effect of sampling time distributions and delays caused by queues and equipment failures must be added to this value.

Process

Van		Equipment		Time		Loop	
Number	Name	Number	Name	Number	Value	Number	Value
9	HQ	01	Server	70	600*Exp	01	1
4	Information						
		01	Rolodex	17	180+60	11	Attribute A
		02	File	17	180±60	11	Attribute A
25	QRMP						
		01	Table	13	120+15	11	Attribute A
		02	QRMP	61	300±23/Cy	11	Attribute A
9	HQ	01	Server	21	300±60	01	1

ETLSIM Route Control Matrix

9017001	4011711	4021711	25011311	25026111	9012101